DIW Berlin

German Institute
for Economic Research

Discussion Papers

598

Boriss Siliverstovs
Konstantin A. Kholodilin

On Selection of Components for a Diffusion Index Model: It's not the Size, It's How You Use It

Berlin, June 2006

Opinions expressed in this paper are those of the author and do not necessarily reflect views of the institute.

IMPRESSUM

DIW Berlin
German Institute for Economic Research
Königin-Luise-Str. 5
14195 Berlin
Tel. +49 (30) 897 89-0
Fax +49 (30) 897 89-200
http://www.diw.de

ISSN print edition 1433-0210
ISSN electronic edition 1619-4535

Available for free downloading from the DIW Berlin website.

On Selection of Components for a Diffusion Index Model: It's not the Size, It's How You Use It [§]

Boriss Siliverstovs[*] Konstantin A. Kholodilin[**]

June 9, 2006

Abstract

This paper suggests a novel approach to pre-selection of the component series of the diffusion index based on their individual forecasting performance. It is shown that this targeted selection allows substantially improving the forecasting ability compared to the diffusion index models that are based on the largest available data set.

Keywords: Diffusion index; forecasting; optimal subset of data.

JEL classification: E32; C10

[§]We are grateful to Jiří Slačálek for his insightful comments and to Todd E. Clark for the computer code he kindly provided to us.

[*]DIW Berlin, Königin-Luise Straße 5, 14195 Berlin, Germany, e-mail: bsiliverstovs@diw.de

[**]DIW Berlin, Königin-Luise Straße 5, 14195 Berlin, Germany, e-mail: kkholodilin@diw.de

"Win with ability, not with numbers".

Generalissimo Aleksandr Vasiliyevich Suvorov

1 Introduction

Since the seminal paper of Stock and Watson (2002) there have been multiple papers trying to apply the methodology of the diffusion index to the data of various countries such as Schneider and Spitzer (2004) for Austria, Brisson et al. (2001) — for Canada, Shintani (2003) — for Japan, den Reijer (2005) — for the Netherlands, Camacho and Sancho (2003) — for Spain, Marcellino et al. (2005) — for the UK, and Dreger and Schumacher (2004) and Schumacher (2005) — for Germany, *inter alia*. The euphoric hope was to take advantage of the extremely rich data sets, comprised of hundreds or even thousands of time series, available in many industrialized economies to extract the diffusion indices and to improve significantly the forecasts of the main macroeconomic aggregates.

While several studies like Schneider and Spitzer (2004), Brisson et al. (2001), Shintani (2003), and Camacho and Sancho (2003), report significant improvements in the forecast accuracy using the methodology of Stock and Watson (2002), there is a number of studies that cast doubt on usefulness of such method in the forecasting exercise, e.g., see Giacomini and White (2003), Dreger and Schumacher (2004), and Marcellino et al. (2005). Given such mixed results, a question on further improvements over the procedure of Stock and Watson (2002) arises.

The path of improvements can be at least twofold. On the one hand, one can try to elaborate on a more sophisticated technique of extraction of the common factors from the available multitude of the data. This is the path taken in Kapetanions and Marcellino (2004) and Forni et al. (2000, 2004), where the parametric state-space dynamic factor model and the generalized dynamic factor model have been suggested, respectively. On the other hand, one can achieve improvements in the forecasting ability of the static factor models of Stock and Watson (2002) if one approaches critically the selection of the components, which constitutes the basis for the diffusion index. For example, den Reijer (2005) suggests prior to construction of the diffusion index to determine the properties

of the individual components, i.e., whether they lead or lag the reference time series of forecasting interest. Furthermore, he shows that for the whole set of leading components there exists an "optimal" (not necessarily maximum) size of the subset of data, at which the forecasting performance is maximized.

In this paper, we follow the latter path by introducing another criterion for component selection, on which basis the diffusion index is constructed. We argue that a leading time series need not necessarily imply a better forecasting performance. Hence, if one is interested in ultimate forecast improvement then it is more logical to select those component series, which are individually better at forecasting the variable of interest. Then, as in the case of pooling the forecasts, one can hope that the diffusion index extracted from the set of such variables will have the improved forecasting performance.

In order to illustrate our approach we have applied component selection and forecasting procedures to the German real GDP over the forecasting period 1998:I–2005:IV. As indicated above, such approach to component selection has yielded large improvement in the forecasting ability over the diffusion index model based on the entire data set.

This paper is structured as follows. The next section presents the forecasting model. Section 3 compares the standard diffusion index models with those based on the component pre-selection. Section 4 describes the data. In Section 5 the diffusion index models are set up. In Section 6 the empirical results are reported, and the last section concludes.

2 Forecasting Model

The forecasting model is defined as follows. Let y_t^h be the $h-$th difference of log of real GDP. Then for the quarterly data that we have, y_t^1, y_t^2, and y_t^4, denotes the quarterly, the semi-annual, and the annual growth rates of real GDP. Note that both y_t^1 and y_t^2 are calculated on the year-on-year basis. The forecast equation is

$$y_{t+h}^h = \alpha + \sum_{i=0}^{p} \beta_i y_{t-i}^1 + \sum_{j=0}^{q} \gamma_j' z_{t-j} + \varepsilon_{t+h}^h, \tag{1}$$

where $h-$steps ahead growth rates of the reference time series are linearly projected

on its own quarterly growth rates, y^1_{t-j}, as well as on the leading indicator values available at time t, z_{t-j}, for $i, j = 0, 1, 2, ..., q$. In our exercise we have restricted the maximum lag length to four, $p, q = 4$.

3 "Small-scale" vs. "large-scale" diffusion indices

Generally, the forecast can be considered as a linear projection of the dependent variable on some information set:

$$\hat{y}^h_{t+h} = proj(y_{t+h}|\Omega_t) \tag{2}$$

When the number of time series is large compared to the sample size, there is a need to reduce dimensionality of the set of regressors. One way to do it is to apply the principal component analysis (PCA), as suggested in Stock and Watson (2002). In their model they advocate the use of as many time series as possible to extract the principal components. That is why their approach is known as the "large-scale" diffusion index, since it uses the whole available information set:

$$\hat{y}^h_{t+h} = proj(y_{t+h}|f(\Omega_t)) \tag{3}$$

where $f(.)$ is the operator standing for the principal component analysis.

However, the diffusion indices resulting from complete data set may be spoiled by the irrelevant time series dominating the relevant ones. Therefore we claim that it is important to carefully select the information set for the extraction of diffusion indices. This procedure can be referred to as "small-scale" diffusion index.

The selection of the information subset can be done according to different criteria. The method described in den Reijer (2005) selects the subset, Ω^{Lead}_t, such that all its components are leading the dependent variable, y^h_{t+h}. Below we will call it the *leading-indicators based* "small-scale" index. In contrast, our method selects an information subset Ω^{RMSE}_t, whose members have the out-of-sample RMSE, which is lower than that of a benchmark, or NAIVE, model. The latter is defined by setting all the coefficients β_i and

γ_i in equation (1) to zero. Our approach will be denoted as the *forecasting-performance based* "small-scale" index.

4 Data

For our empirical exercise we use the German data, which were taken from the data base of the Deutsche Bundesbank. The complete data set is comprised of 145 seasonally adjusted monthly time series, which are listed in Table 1. The sample covers the period from January 1991 through December 2005. The variable to be forecast is the quarterly and year-on-year growth rates the real German GDP. The real GDP in levels is available from the first quarter 1991 up to the last quarter 2005. The out-of-sample forecasts were made for the period 1998:I–2005:IV including 32 observations.

5 Construction of diffusion indices

As mentioned above we compare the performance of the three diffusion indices. All of them are based on the balanced panel. Given the fact that we dispose of the monthly data, we have two options in constructing the diffusion indices: (1) first to extract the diffusion indices from the monthly time series and then to aggregate them to the quarterly frequency and (2) first to aggregate the monthly time series to the quarterly ones and then to construct the diffusion indices.

The first one is the "large-scale" diffusion index and it is extracted from the complete data set using the standard procedure described in Stock and Watson (2002).

The second is the leading-indicators based "small-scale" diffusion indices suggested in den Reijer (2005). The information subsets are comprised of 69 and 82 time series at the forecasting horizons $h = 1$ and $h = 4$, respectively. The selection rule was simple: choose those time series that lead the quarterly (when $h = 1$) or year-on-year (when $h = 4$) growth rates of GDP for h periods or more.

The third diffusion index is our forecasting-performance based index. It is constructed in the following way. At the first stage all the time series were aggregated to the quarterly

frequency. Then each time series was used to obtain the out-of-sample forecasts of the quarterly and year-on-year growth rates of the real German GDP using the model defined in (1). The Root Mean Square Errors (RMSE) for each component series and both forecasting horizons were computed. The time series that led to the better forecasts than the NAIVE model were chosen as the components of the "small-scale" diffusion index.

At horizon $h = 1$ the following seventeen components were selected: WU0004, WU1032, WU0018, WU0019, WU0115, WU0017, WU8616, WU0113, WX3950, WU035A, WU0024, EU3210, EU3100, EU3220, YX900D, EU2001, and XS5600. The first eleven time series belong to the category "Yields on debt securities outstanding issued by residents", whereas the last six characterize the exports of goods and services and transfers and the price competitiveness of Germany on the world market. At horizon $h = 4$ only nine component series were retained: WX9727, XS5601, UUGA01, YX900D, UXA007, EU4169, EU4170, EU3220, and WU0010. Out of them two are the indicators of the credit markets, two relate to the prices, four are the indicators of the balance of payments, and one is the orders received.

The choice of the time series entering the information subsets, especially of the variables related to the credit market and foreign trade, appear to be sensible, since these two sectors play an important role in the German economy.

The notation we use for the various diffusion indices is summarized in Table 2. The "Time aggregation" refers to the two options of constructing the diffusion indices mentioned in the previous paragraph. Since we make forecasts at two horizons, the information subsets of the leading or best forecasting time series may be different. Therefore the "small-scale" indices will be different at different forecasting horizons. This is reflected in suffices "H1" and "H4".

6 Results

The results of the out-of-sample forecasting using all these models are reported in Tables 3 and 4 for forecast horizons equal 1 and 4 quarters, respectively. The models are grouped in these tables as follows:

(A) forecasting-performance based "small-scale" diffusion indices;

(B) leading-indicators based diffusion indices;

(C) "large-scale" diffusion indices;

(D) benchmark NAIVE model.

There are several important results to be discussed. First, a mechanic application of the "large-scale" diffusion index model of Stock and Watson (2002) yields the forecast RMSE that is greater than that reported for the benchmark NAIVE model. This is the unsatisfactory result and clearly contradicts the initial motivation for use of such models that are based on the largest available data sets.

Second, our approach, which is based on the pre-selection of the time series components that enter into the diffusion index, results in significant improvement of forecast accuracy and dominates all other diffusion index models examined in this paper.

Third, it turns out that the forecasting performance of our "small-scale" diffusion index models depends on the way the time series comprising the index were aggregated, as discussed in the first paragraph of Section 5. At the forecast horizon $h = 1$, the first aggregation approach yields the best forecasting accuracy, at $h = 4$ — the second approach. Hence, one cannot beforehand choose the aggregation method while constructing the "small-scale" diffusion indices. Below we will concentrate on the best forecasting-performance based diffusion index.

Fourth, comparison of the forecasting accuracy of our "small-scale" forecasting-performance based diffusion index model with the alternative models has shown that our approach yields lower forecast RMSE than that observed for the benchmark NAIVE model, the diffusion index model suggested in den Reijer (2005), and more importantly, than that observed for the "large-scale" diffusion index model of Stock and Watson (2002). As seen, for the forecast horizon $h = 1$ improvement in terms of the forecast RMSE comprises 15%, up to 15%, and up to 22%, respectively. Moreover, for the forecast horizon $h = 4$ the gain in forecast accuracy is even larger. Namely, it is 20% — relative to the NAIVE

model, 41% — relative to the approach of den Reijer (2005), and 29% — relative to the "large-scale" model.

Fifth, in order to check whether the observed differences in the forecast RMSE are statistically significant we have conducted the modified forecast accuracy Diebold-Mariano test (see Harvey et al. (1997)) for the non-nested models and the MSE-F test of Clark and McCracken (2005) for the nested models (our diffusion index model versus the NAIVE model). The statistical test results generally support the superiority of our approach. We are able to reject the null hypothesis of equal forecast accuracy with the NAIVE model at the 1% significance level for both forecast horizons, with the model of den Reijer (2005) — at the 5% for both forecast horizons, and for the "large-scale" model — at the 5% significance level for $h = 1$.

Sixth, in order to check the robustness of our results we have conducted the forecast encompassing tests as suggested in Harvey et al. (1998) for the non-nested models and the ENC-F test of Clark and McCracken (2005) for the nested models (our diffusion index model versus the NAIVE model). The results of these tests give even stronger credit to our approach. As seen from the last two columns of Tables 3 and 4, the null hypothesis that our "small-scale" forecasting-performance based diffusion index model is encompassed by any alternative model is rejected at the conventional significance levels, whereas the null hypothesis that it encompasses the alternative models is never rejected at the 5% significance level at all forecast horizons.

It should be noted that the pre-selection of individual time series, from which the diffusion index is extracted, is conducted here *ex post*. In other words, the diffusion index components were selected using the maximum available information, i.e. the out-of-sample forecast RMSE over the whole forecasting period was used as the selection criterion. We acknowledge that this is a limitation of our paper as this approach is not feasible in the real time forecasting exercise. Nevertheless, given the small sample size (60 observations in total) available to us, we chose to proceed so in order to illustrate the point that a diffusion index model based on the subset of the total database could have the better forecast accuracy than the diffusion index model based on the total data set.

7 Conclusion

In this paper we showed that the blind use of the "large-scale" diffusion index models as suggested in Stock and Watson (2002), which is based on employment of the largest available data sets, does not automatically guarantee superior forecast accuracy. Moreover, this model can be even beaten by the NAIVE model.

As the main contribution of this paper, we show how the forecast accuracy of the diffusion index models can be significantly improved by carefully selecting components of the diffusion index. Thence we suggest a new approach to pre-selection of the time series from which the diffusion index is extracted. The selection criterion was an out-of-sample forecasting performance of each component individually. Those time series that outperformed the NAIVE model were chosen as component series of the new diffusion index.

We have applied our approach to the forecasting of the German GDP, and the outcome of our empirical exercise successfully confirms the usefulness of the diffusion index component pre-selection.

References

Brisson, M., B. Campbell, and J. Galbraith (2001). Forecasting some low-predictability time series using diffusion indices. Technical Report 2001s-46, CIRANO.

Camacho, M. and I. Sancho (2003). Spanish diffusion indexes. *Spanish Economic Review 5*(3), 173–203.

Clark, T. and M. McCracken (2005). Evaluating direct multistep forecasts. *Econometric Reviews 24*(4), 369–404.

den Reijer, A. H. J. (2005). Forecasting Dutch GDP using large scale factor models. Technical Report 028, Netherlands Central Bank, Research Department.

Dreger, C. and C. Schumacher (2004). Estimating large-scale factor models for eco-

nomic activity in Germany: Do they outperform simpler models? *Jahrbücher für Nationalökonomie und Statistik 224*, 732–750.

Forni, M., M. Hallin, M. Lippi, and L. Reichlin (2004). The generalized dynamic factor model: Consistency and rates. *Journal of Econometrics 119*, 231–255.

Forni, M., M. H. M. Lippi, and L. Reichlin (2000). The generalized dynamic-factor model: Identification and estimation. *The Review of Economics and Statistics 82*, 540–554.

Giacomini, R. and H. White (2003). Tests of conditional predictive ability. Boston College Working Papers in Economics 572, Boston College Department of Economics.

Harvey, D., S. J. Leybourne, and P. Newbold (1997). Testing the equality of prediction mean squared errors. *International Journal of Forecasting 13*, 281–291.

Harvey, D. I., S. J. Leybourne, and P. Newbold (1998). Tests for forecast encompassing. *Journal of Business & Economic Statistics 16*(2), 254–59.

Kapetanions, G. and M. Marcellino (2004). A parametric estimation method for dynamic factor models of large dimensions.

Marcellino, M., A. Banerjee, and M. J. Artis (2005). Factor forecasts for the uk. *Journal of Forecasting 24*(4), 279–298.

Schneider, M. and M. Spitzer (2004). Forecasting Austrian GDP using the generalized dynamic factor model. Technical Report 89, Österreichische Nationalbank.

Schumacher, C. (2005). Forecasting German GDP using alternative factor models based on large datasets. *Deutsche Bundesbank Discussion Paper* (24/2005).

Shintani, M. (2003). Nonlinear forecasting analysis using diffusion indexes: An application to Japan. Technical Report 0322, Department of Economics, Vanderbilt University.

Stock, J. H. and M. W. Watson (2002). Macroeconomic forecasting using diffusion indexes. *Journal of Business and Economic Statistics 20*(2), 147–162.

Appendix

Table 1: The list of component series of the diffusion index, 1991:1-2005:12

1. Amounts outstanding of debt securities issued by residents / Bank debt securities / Mortgage Pfandbriefe DM/EURO (complete series based on Euro) WU0002
2. Amounts outstanding of debt securities issued by residents / Bank debt securities / Public Pfandbriefe DM/EURO (complete series based on Euro) WU0010
3. Amounts outstanding of debt securities issued by residents/ Bank debt securities issued by special purpose credit institutions DM/EURO (complete series based on Euro) WU0011
4. Amounts outstanding of debt securities issued by residents Bank debt securities / Other bank debt securities DM/EURO (complete series based on Euro) WU0012
5. Amounts outstanding of debt securities issued by residents / Corporate bonds DM/EURO (complete series based on Euro) WU0013
6. Amounts outstanding of debt securities issued by residents / Public debt securities DM/EURO (complete series based on Euro) WU0014
7. Amounts outstanding of debt securities issued by residents / Bank debt securities DM/EURO (complete series based on Euro) WU0015
8. Amounts outstanding of debt securities issued by residents / Total DM/EURO (complete series based on Euro) WU0016
9. Amounts outstanding of foreign DM/EURO debt securities issued by German-managed syndicates DM/EURO (complete series based on Euro) WU0044
10. Yields on debt securities outstanding issued by residents / Public debt securities / Monthly average PROZENT (complete series based on Euro) WU0004
11. Yields on debt securities outstanding issued by residents / Total / Monthly average PROZENT (complete series based on Euro) WU0017
12. Yields on debt securities outstanding issued by residents / Mortgage Pfandbriefe / Monthly average PROZENT (complete series based on Euro) WU0018
13. Yields on debt securities outstanding issued by residents / Public Pfandbriefe / Monthly average PROZENT (complete series based on Euro) WU0019
14. CDAX share price index / End of month / End 1987 = 100 1987=100 (complete series based on Euro) WU001A
15. Yields on debt securities outstanding issued by residents / Corporate bonds / Monthly average PROZENT (complete series based on Euro) WU0022
16. Yield on foreign DM/EURO bonds outstanding issued by a German-managed syndicates / Monthly average PROZENT (complete series based on Euro) WU0024
17. Yields on debt securities outstanding issued by residents / Listed Federal securities / Monthly average PROZENT (complete series based on Euro) WU0115
18. German bond index (REX) / End of month Prozent (complete series based on Euro) WU035A
19. Yields on debt securities outstanding issued by residents / Bank debt securities / Monthly average PROZENT (complete series based on Euro) WU1032
20. German share index (DAX) / End of month / End 1987 = 1000 / backwards linked with the index of the Börsen-Zeitung 87 =1000 (complete series based on Euro) WU3141
21. Yields on debt securities outstanding issued by residents / Bank debt securities / Mean residual maturity of more than 9 and up to 10 years / Monthly average Prozent (complete series based on Euro) WU8616
22. Yields on listed Federal securities (only bonds eligible as underlying instruments for future contracts are included, calculated as unweighted averages) with a residual maturity of more than 9 and up to 10 years / Monthly average Prozent (complete series based on Euro) WX3950
23. Net sales receipts of funds open to the general public / Open-end real estate funds DM/EURO (complete series based on Euro) WU0040
24. Net sales receipts of funds open to the general public DM/EURO (complete series based on Euro) WU0113
25. Net sales receipts of specialized funds DM/EURO (complete series based on Euro) WU0166

26. Net purchase(+) or net sales (-) of foreign mutual fund shares by residents at transaction value DM/EURO (complete series based on Euro) WU0167

27. Sales (=total purchases) of domestic an foreign mutual fund shares DM/EURO (complete series based on Euro) WX4215

28. Sales of domestic mutual fund shares (net sales receipt) DM/EURO (complete series based on Euro) WX4216

29. Purchases of domestic and foreign mutual fund shares by residents M/EURO (complete series based on Euro) WX4217

30. Purchases of foreign mutual fund shares by domestic credit institutions including building and loan associations DM/EURO (complete series based on Euro) WX4220

31. Purchases of foreign mutual fund shares by domestic non-banks DM/EURO (complete series based on Euro) WX4223

32. Net purchases or net sales (-) of foreign mutual fund shares by non-residents at transaction values DM/EURO (complete series based on Euro) WX4225

33. Purchases of domestic and foreign mutual fund shares by domestic credit institutions including building and loan associations DM/EURO (complete series based on Euro) WX4226

34. Purchases of domestic and foreign mutual fund shares by domestic non-banks DM/EURO (complete series based on Euro) WX4228

35. Net sales receipts of funds open to the general public / Securities-based funds DM/EURO (complete series based on Euro) WX9727

36. Germany / Production / Working-day adjusted / Production sector / including construction 2000=100 (complete series based on Euro) UXNA01

37. Germany / Production / Working-day adjusted / Intermediate goods 2000=100 (complete series based on Euro) UXNA04

38. Germany / Production / Working-day adjusted / Capital goods 2000=100 (complete series based on Euro) UXNA05

39. Germany / Production / Working-day adjusted / Durable consumer goods 2000=100 (complete series based on Euro) UXNA06

40. Germany / Production / Working-day adjusted / Non-durable consumer goods 2000=100 (complete series based on Euro) UXNA07

41. Germany / Production / Working-day adjusted / Manufacture of chemicals and chemical products 2000=100 (complete series based on Euro) UXNA25

42. Germany / Production / Working-day adjusted / Manufacture of basic metals 2000=100 (complete series based on Euro) UXNA33

43. Germany / Production / Working-day adjusted / Manufacture of machinery and equipment 2000=100 (complete series based on Euro) UXNA39

44. Germany / Production / Working-day adjusted / Manufacture of motor vehicles, trailers and semi-trailers 2000=100 (complete series based on Euro) UXNA50

45. Germany / Production / Working-day adjusted / Construction sector / Total 2000=100 (complete series based on Euro) UXNA61

46. Germany / Production / Working-day adjusted / Energy 2000=100 (complete series based on Euro) UXNI61

47. Germany / Production / Working-day adjusted / Industry 2000=100 (complete series based on Euro) UXNI63

48. Germany / Orders received / Value / Working-day adjusted / Total 2000=100 (complete series based on Euro) UXA001

49. Germany / Orders received / Value / Working-day adjusted / Total / Intermediate goods 2000=100 (complete series based on Euro) UXA004

50. Germany / Orders received / Value / Working-day adjusted / Total / Capital goods 2000=100 (complete series based on Euro) UXA007

51. D-Ges / Orders received / Value / Total / Gebrauchsgüterproduzenten / Working-day adjusted 2000=100 (complete series based on Euro) UXA010

52. D-Ges / Orders received / Value / Total / Verbrauchsgüterproduzenten / Working-day adjusted 2000=100 (complete series based on Euro) UXA013

53. Germany / Orders received / Value / Working-day adjusted / Total / Consumer goods 2000=100 (complete series based on Euro) UXA742

54. Germany / Orders received / Value / Working-day adjusted / Construction sector 2000=100 (complete series based on Euro) UXDA01

55. Germany / Orders received / Value / Working-day adjusted / Housing construction 2000=100 (complete series based on Euro) UXDA03

56. Germany / Orders received / Value / Working-day adjusted / Industrial clients 2000=100 (complete series based on Euro) UXDA31

57. Germany / Orders received / Value / Working-day adjusted / Public sector clients 2000=100 (complete series based on Euro) UXDA32

58. Retail turnover / Value / Total / Working-day adjusted 2003=100 (complete series based on Euro) UXHJ45

59. Retail turnover / Value / Including retail of motor vehicles and including petrol stations / Working-day adjusted 2003=100 (complete series based on Euro) UXHJ87

60. Retail turnover / Volume / Total / Working-day adjusted 2003=100 (complete series based on Euro) UXHK45

61. Retail turnover / Volume / Including retail of motor vehicles and including petrol stations / Working-day adjusted 2003=100 (complete series based on Euro) UXHK87

62. Germany / Employed as per ESA 95 1) / Work-place concept / Monthly averages Anzahl (complete series based on Euro) UUBA14

63. Germany / Unemployment / Total / 1) Anzahl (complete series based on Euro) UUCC01

64. Germany / Job vacancies / Total / 1) Anzahl (complete series based on Euro) UUCC04

65. Germany / Short-time workers / Total / Number of participants / Mid-month data Anzahl (complete series based on Euro) UUCC05

66. Germany / Monthly report in construction industry (WZ93) 1) / Employees / Total / All enterprises Anzahl (complete series based on Euro) UUMB01

67. Germany / Employees / Enterprises (monthly report) / Mining and quarrying, manufacturing Anzahl (complete series based on Euro) UUOA01

68. Germany / Consumer price index / Original data / Total 2000=100 (complete series based on Euro) UUFA01

69. Germany / Consumer price index / Original data / 011 Food 2000=100 (complete series based on Euro) UUFA03

70. Germany / Consumer price index / Original data / Housing rent (net) and incidental housing expenses 2000=100 (complete series based on Euro) UUFB61

71. Germany / Consumer price index / Original data / Energy 2000=100 (complete series based on Euro) UUFB75

72. Germany / Producer prices, agricultural products / Total (excluding turnover tax) 2000=100 (complete series based on Euro) UUGA01

73. Germany / Producer prices, industrial products (domestic sales) / Original data / Total 2000=100 (complete series based on Euro) UUZF01

74. Germany / Import prices / Original data / Total 2000=100 (complete series based on Euro) UUZI01

75. Germany / Export prices / Original data / Total 2000=100 (complete series based on Euro) UUZJ01

76. HWWA index of raw material prices for the euro area based on the euro / Other raw materials 2000=100 (complete series based on Euro) YU0516

77. HWWA index of raw material prices for the euro area based on the euro / Energy 2000=100 (complete series based on Euro) YU0517

78. Trade in goods / External trade / Exports (fob) DM/Euro (complete series based on Euro) EU2001

79. Service transactions / Total / Receipts DM/Euro (complete series based on Euro) EU2100

80. Trade in goods / External trade / Imports (cif) DM/Euro (complete series based on Euro) EU3001

81. Service transactions / Total / Expenditure DM/Euro (complete series based on Euro) EU3100

82. Income / Total / Expenditure DM/Euro (complete series based on Euro) EU3170

83. Trade in goods / External trade / Balance DM/Euro (complete series based on Euro) EU4001

84. Trade in goods / Supplementary trade items, balance DM/Euro (complete series based on Euro) EU4006

85. Service transactions / Total / Balance DM/Euro (complete series based on Euro) EU4100

86. Income / Total / Balance DM/Euro (complete series based on Euro) EU4170

87. Current transfers / Total / Balance DM/Euro (complete series based on Euro) EU4220

88. Financial transactions / Long-term credit transactions of monetary financial institutions / Total DM/Euro (complete series based on Euro) EU4395

89. Financial transactions / Short-term credit transactions of monetary financial institutions / Total / Balance DM/Euro (complete series based on Euro) EU4510

90. Financial transactions / Credit transactions and other investment / Balance DM/Euro (complete series based on Euro) EU4626

91. Balance on current account DM/Euro (complete series based on Euro) EU4710

92. Balance of unclassifiable transactions DM/Euro (complete series based on Euro) EU4720

93. Exports / Value / Total / Seasonally adjusted DM/EURO (complete series based on Euro) XS5600

94. Imports / Value / Total / Seasonally adjusted DM/EURO (complete series based on Euro) XS5601
95. Foreign trade balance / Value / Total / Seasonally adjusted DM/EURO (complete series based on Euro) XS5602
96. Compensation of employees / Total / Receipts DM/Euro (complete series based on Euro) EU2151
97. Investment income / For dividends / Receipts DM/Euro (complete series based on Euro) EU2152
98. Investment income / Income from mutual fund shares / Receipts DM/Euro (complete series based on Euro) EU2153
99. Investment income / Interest on bonds / Receipts DM/Euro (complete series based on Euro) EU2154
100. Investment income / For portfolio investment / Total / Receipts DM/Euro (complete series based on Euro) EU2156
101. Investment income / For direct investment / Total / Receipts DM/Euro (complete series based on Euro) EU2164
102. Investment income / Interest on loans / Total / Receipts DM/Euro (complete series based on Euro) EU2168
103. Investment income / Total / Receipts DM/Euro (complete series based on Euro) EU2169
104. Income / Total / Receipts DM/Euro (complete series based on Euro) EU2170
105. Compensation of employees / Total / Expenditure DM/Euro (complete series based on Euro) EU3151
106. Investment income / For dividends / Expenditure DM/Euro (complete series based on Euro) EU3152
107. Investment income / Interest on bonds / Expenditure DM/Euro (complete series based on Euro) EU3154
108. Investment income / Interest on public bonds / Expenditure DM/Euro (complete series based on Euro) EU3155
109. Investment income / For portfolio investment / Total / Expenditure DM/Euro (complete series based on Euro) EU3156
110. Investment income / For direct investment / Total / Expenditure DM/Euro (complete series based on Euro) EU3164
111. Investment income / Interest on loans / Total / Expenditure DM/Euro (complete series based on Euro) EU3168
112. Investment income / Total / Expenditure DM/Euro (complete series based on Euro) EU3169
113. Compensation of employees / Total / Balance DM/Euro (complete series based on Euro) EU4151
114. Investment income / Total / Balance DM/Euro (complete series based on Euro) EU4169
115. Current transfers / Public / EU / Transfers from non-residents DM/Euro (complete series based on Euro) EU2201
116. Current transfers / Public / Tax revenue DM/Euro (complete series based on Euro) EU2203
117. Current transfers / Public / Total / Transfers from non-residents DM/Euro (complete series based on Euro) EU2210
118. Current transfers / Private / Pensions and maintenance payments / Transfers from non-residents DM/Euro (complete series based on Euro) EU2211
119. Current transfers / Private / Total / Transfers from non-residents DM/Euro (complete series based on Euro) EU2215
120. Current transfers / Total / Transfers from non-residents DM/Euro (complete series based on Euro) EU2220
121. Capital transfers / Private / Total / Transfers from non-residents DM/Euro (complete series based on Euro) EU2553
122. Capital transfers / Total / Transfers from non-residents DM/Euro (complete series based on Euro) EU2555
123. Current transfers / Public / EU / Transfers to non-residents DM/Euro (complete series based on Euro) EU3201
124. Current transfers / Public / Other international organizations / Transfers to non-residents DM/Euro (complete series based on Euro) EU3202
125. Current transfers / Public / Tax refunds DM/Euro (complete series based on Euro) EU3203
126. Current transfers / Public / Transfers to developing countries / Transfers to non-residents DM/Euro (complete series based on Euro) EU3204
127. Current transfers / Public / Pensions and maintenance payments / Transfers to non-residents DM/Euro (complete series based on Euro) EU3205
128. Current transfers / Public / Total / Transfers to non-residents DM/Euro (complete series based on Euro) EU3210
129. Current transfers / Private / Pensions and maintenance payments / Transfers to non-residents DM/Euro (complete series based on Euro) EU3211

130. Current transfers / Private / Total / Transfers to non-residents DM/Euro (complete series based on Euro) EU3215

131. Current transfers / Total / Transfers to non-residents DM/Euro (complete series based on Euro) EU3220

132. Capital transfers / Public / Total / Transfers to non-residents DM/Euro (complete series based on Euro) EU3551

133. Capital transfers / Total / Transfers to non-residents DM/Euro (complete series based on Euro) EU3555

134. Current transfers / Public / Total / Balance DM/Euro (complete series based on Euro) EU4210

135. Current transfers / Private / Total / Balance DM/Euro (complete series based on Euro) EU4215

136. Indicator of the German economy's price competitiveness against 19 countries / based on consumer prices 1Q99=100 (complete series based on Euro) YX900D

137. Money market rates reported by Frankfurt banks / Overnight money / Monthly average % p.a. (complete series based on Euro) SU0101

138. Money market rates reported by Frankfurt banks / Overnight money / Lowest rate of month % p.a. (complete series based on Euro) SU0102

139. Money market rates reported by Frankfurt banks / Overnight money / Highest rate of month % p.a. (complete series based on Euro) SU0103

140. Money market rates reported by Frankfurt banks / One-month funds / Monthly average % p.a. (complete series based on Euro) SU0104

141. Money market rates reported by Frankfurt banks / Three-month funds / Monthly average % p.a. (complete series based on Euro) SU0107

142. Money market rates reported by Frankfurt banks / Three-month funds / Lowest rate of month % p.a. (complete series based on Euro) SU0108

143. Money market rates reported by Frankfurt banks / Three-month funds / Highest rate of month % p.a. (complete series based on Euro) SU0109

144. Money market rates reported by Frankfurt banks / Six-month funds / Monthly average % p.a. (complete series based on Euro) SU0250

145. Money market rates reported by Frankfurt banks / Twelve-month funds / Monthly average % p.a. (complete series based on Euro) SU0253

Table 2: Symbolic notation for the diffusion indices

Diffusion index model	Time aggregation: Month-to-quarter	Time aggregation: Quarter
Large-scale	F_{M2Q}	F_Q
Based on leading-indicators		
horizon h=1	$FH1^{Lead}_{M2Q}$	$FH1^{Lead}_{Q}$
horizon h=4	$FH4^{Lead}_{M2Q}$	$FH4^{Lead}_{Q}$
Based on forecasting-performance		
horizon h=1	$FH1^{RMSE}_{M2Q}$	$FH1^{RMSE}_{Q}$
horizon h=4	$FH4^{RMSE}_{M2Q}$	$FH4^{RMSE}_{Q}$

Table 3: $h = 1$

		RMSE	Rel. RMSE[1]	DM[2]	ENC[3]	ENC[4]
(A)	$FH1_{Q}^{RMSE}$	0.017	0.851	—	—	—
	$FH1_{M2Q}^{RMSE}$	0.020	0.975	0.007	0.001	0.985
(B)	$FH1_{M2Q}^{Lead}$	0.020	0.979	0.003	0.000	0.993
	$FH1_{Q}^{Lead}$	0.018	0.903	0.178	0.051	0.790
(C)	F_{Q}	0.021	1.019	0.148	0.020	0.127
	F_{M2Q}	0.022	1.060	0.037	0.007	0.916
(D)	NAIVE[5]	0.020	1.000	0.000	0.000	—

Notes:
[1] Relative to the RMSE of the NAIVE model. [2] The p-values of the modified Diebold-Mariano test statistic, see Harvey et al. (1997).
[3] The p-values of the forecast encompassing test statistic, the null hypothesis: $FH1_{Q}^{RMSE}$ is encompassed by the corresponding row model, see Harvey et al. (1998).
[4] The p-values of the forecast encompassing test statistic, the null hypothesis: $FH1_{Q}^{RMSE}$ encompasses the corresponding row model, see Harvey et al. (1998).
[5] The p-values of the Diebold-Mariano and of the forecast encompassing test statistics have been calculated using the method for nested models, see Clark and McCracken (2005).

Table 4: $h = 4$

		RMSE	Rel. RMSE[1]	DM[2]	ENC[3]	ENC[4]
(A)	$FH4^{RMSE}_{M2Q}$	0.010	0.789	—	—	—
	$FH4^{RMSE}_{Q}$	0.014	1.064	0.125	0.004	0.276
(B)	$FH4^{Lead}_{M2Q}$	0.016	1.236	0.013	0.000	0.075
	$FH4^{Lead}_{Q}$	0.017	1.257	0.015	0.000	0.092
(C)	F_{M2Q}	0.014	1.033	0.113	0.001	0.088
	F_{Q}	0.014	1.084	0.245	0.025	0.288
(D)	NAIVE[5]	0.013	1.000	0.002	0.001	—

Notes:
[1] Relative to the RMSE of the NAIVE model. [2] The p-values of the modified Diebold-Mariano test statistic, see Harvey et al. (1997).
[3] The p-values of the forecast encompassing test statistic, the null hypothesis: $FH4^{RMSE}_{M2Q}$ is encompassed by the corresponding row model, see Harvey et al. (1998).
[4] The p-values of the forecast encompassing test statistic, the null hypothesis: $FH4^{RMSE}_{M2Q}$ encompasses the corresponding row model, see Harvey et al. (1998).
[5] The p-values of the Diebold-Mariano and of the forecast encompassing test statistics have been calculated using the method for nested models, see Clark and McCracken (2005).